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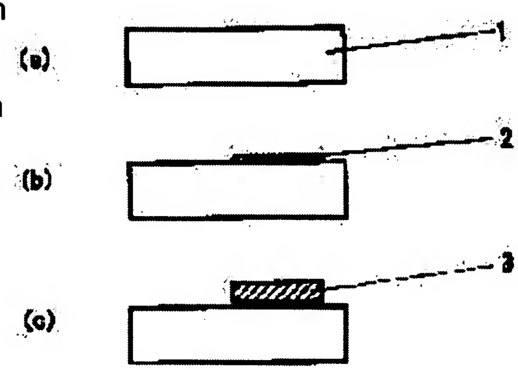
(54) PRODUCTION OF DIAMOND FILM

(57)Abstract:

PROBLEM TO BE SOLVED: To efficiently generate nuclei at the time of synthesizing diamond by an easy means with satisfactory reproducibility and to form a high quality diamond film only in a desired region.

SOLUTION: A soln. contg. dispersed particles of ≤0.1μm average particle diameter is applied to a region on a substrate 1 and a diamond film 3 is grown on the substrate 1. The uniformity and reproducibility of the grown diamond film 3 are considerably improved and a desired diamond film pattern can be formed while growing the diamond film.



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CLAIMS

[Claim(s)]
[Claim 1] The manufacture approach of the diamond film which is the approach of forming the diamond film alternatively on a substrate material, and is characterized by including the process which applies the solution with which mean particle diameter made some fields on a substrate material distribute a particle 0.1 micrometers or less, and the process which grows up the diamond film on said substrate material.
[Claim 2] The manufacture approach of the diamond film characterized by to include the process at which mean particle diameter applies the solution which distributed the particle 0.1 micrometers or less on the substrate material which is the approach of forming the diamond film alternatively on a substrate material, and carried out the laminating of the sacrifice layer to some fields, the process which removes said sacrifice layer, and the process which grows up the diamond film on said substrate material.
[Claim 3] The manufacture approach of the diamond film which is the approach of forming the diamond film alternatively on a substrate material, and is characterized by including the process at which mean particle diameter applies the solution which distributed the particle 0.1 micrometers or less on a substrate material, the process which removes a part of field where said solution was applied, and the process which grows up the diamond film on said substrate material.
[Claim 4] The manufacture approach of the diamond film given in either of claims 1, 2, and 3 by which it is consisting [the particle distributed in the solution which is the approach of forming alternatively and applies the diamond film on a substrate material / of a diamond] characterized.
[Claim 5] The manufacture approach of the diamond film given in either of claims 1, 2, and 3 by which it is being [it is the approach of forming the diamond film alternatively on a substrate material and / the amounts of the particle distributed in the solution to apply / 0.01g or more per 1l. of solutions, and 100g or less] characterized.
[Claim 6] The manufacture approach of the diamond film given in either of claims 1, 2, and 3 by which it is or more 1x1016 per 1l. of solutions, and being [it is the approach of forming the diamond film alternatively on a substrate material and / the number of the particles distributed in the solution to apply / 1x1020] or less characterized.
[Claim 7] The manufacture approach of the diamond film given in either of claims 1, 2, and 3 by which it is being [it is the approach of forming the diamond film alternatively on a substrate material and / the solution to apply / water or alcohol] characterized.
[Claim 8] The manufacture approach of the diamond film given in either of claims 1, 2, and 3 characterized by dropping said solution at the substrate material which is the approach of forming the diamond film alternatively on a substrate material, and the method of application of a solution rotated.
[Claim 9] The spreading consistency of the particle which is the approach of forming the diamond film alternatively on a substrate material, and was applied on the substrate material is per [1x108] square centimeter. The manufacture approach of the diamond film given in either of claims 1, 2, and 3 characterized by being more than an individual.
[Claim 10] The manufacture approach of the diamond film given in either of claims 1, 2, and 3 to which the substrate material which is the approach of forming alternatively and uses the diamond film on a

substrate material is characterized by being silicon.
[Claim 11] The manufacture approach of the diamond film given in either of claims 1, 2, and 3 characterized by being the approach of forming the diamond film alternatively on a substrate material, and the sacrifice layer which carried out the laminating on the substrate material being photoresist material.
[Claim 12] The manufacture approach of the diamond film given in either of claims 1, 2, and 3 by which it is forming [are the approach of forming the diamond film alternatively, and / the diamond film / by the vapor phase synthetic method]-on substrate material characterized.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the selective growth approach of the diamond film used as the semi-conductor in electronic industry, or an insulator layer especially about the manufacture approach of the diamond film.
[0002]
[Description of the Prior Art] Also industrially, the diamond film formed by approaches, such as a chemistry vapor phase synthetic method (CVD method), attracts attention in recent years as the semi-conductor which has an unprecedented property, and an insulator layer ingredient. because, a diamond -- a wideband gap ingredient (forbidden-band width of face: about 5.5eV) -- it is -- the property -- doping -- the possibility of semi-conductor-izing, a high degree of hardness, abrasion resistance, and high temperature conductivity -- it is inactive chemically -- etc. -- it is because it is very suitable as an electronic device ingredient of various fields. In addition, generally a diamond can form a carbon system type of gas and hydrogen gas with the vapor phase synthetic method made into material gas, and has a predominance also the manufacture-field.
[0003] However, in case the actually good diamond film is formed, control of the growth nucleus in the initial process of formation is important. It is because it is difficult for the growth origination of nucleus to make it the shape of film few when the diamond film is formed without generally processing in any way on substrate materials, such as silicon. so," which installs a substrate material into the solution in which the diamond abrasive grain (particle size: several micrometers - dozens of micrometers) was made to mix, impresses a supersonic wave, and usually damages the front face of a substrate material as pretreatment of a substrate material as a conventional technique -- it damages and processing" is performed.
[0004] Moreover, there is patterning of the diamond film in one of the techniques for using the obtained diamond film industrially. As the patterning approach of the diamond film of having a desired configuration, only a desired field has etching which performs removal of the selection grown method into which the diamond film is grown up, or the garbage after film formation. As a conventional technique, the former forms the part which processes by the above damaging, and the part which is not performed on a substrate material, and the technique of growing up the film only into a desired field is performed. Moreover, as the latter, the mask material patternized on the diamond film is arranged, and the technique of removing only an unnecessary diamond layer by the dry etching using oxygen gas etc. is performed.
[0005]
[Problem(s) to be Solved by the Invention] Although it damaged conventionally and processing was made if the substrate material for urging the karyogenesis of a diamond as mentioned above was pretreated, there was a trouble that the homogeneity within a field of processing was inadequate, to a substrate material with a big area. Moreover, it obtained and damaged for every processing batch, and the technical problem occurred also in the point of the repeatability of effectiveness. Consequently, the

selective growth which it damages [selective growth] and grows up the diamond film only into a desired field in the processing section and the unsettled section had a technical problem in respect of repeatability etc. similarly.

[0006] Moreover, etching of the diamond film performed by forming mask material had technical problems, like there is possibility that the structure of a diamond film front face will change etc. by carrying out the laminating of that a diamond is comparatively hard to be etched or the mask material while the process which forms mask material, and the process to remove were given.

[0007] therefore , this invention aim at offer the approach of the selective growth which form a good diamond film only in a desired field while it perform karyogenesis at the time of diamond composition often [repeatability] and efficiently by simple technique by mean particle diameter apply to some substrate materials the solution which distributed the particle 0.1 micrometers or less , and grow up a diamond film on said substrate material further in order to solve said technical problem in the conventional technique .

[0008]

[Means for Solving the Problem] The selective-growth approach of the diamond film applied to this invention in order to attain said purpose is the approach of forming the diamond film alternatively on a substrate material, and is the selective-growth approach of the diamond film characterized by to include the process which applies the solution with which mean particle diameter made some fields on a substrate material distribute a particle 0.1 micrometers or less, and the process which grows up the diamond film on said substrate material.

[0009] In order to attain said purpose, moreover, the selective growth approach of the diamond film concerning this invention The process at which mean particle diameter applies the solution which distributed the particle 0.1 micrometers or less on the substrate material which is the approach of forming the diamond film alternatively on a substrate material, and carried out the laminating of the sacrifice layer to some fields, It is the selective growth approach of the diamond film characterized by including the process which removes said sacrifice layer, and the process which grows up the diamond film on said substrate material.

[0010] In order to attain said purpose, moreover, the selective growth approach of the diamond film concerning this invention The process at which it is the approach of forming the diamond film alternatively on a substrate material, and mean particle diameter applies the solution which distributed the particle 0.1 micrometers or less on a substrate material, It is the selective growth approach of the diamond film characterized by including the process which removes a part of field where said solution was applied, and the process which grows up the diamond film on said substrate material.

[0011] Moreover, as for this invention, in said selective growth approach, it is desirable that the particle distributed in the solution to apply consists of a diamond.

[0012] Moreover, as for this invention, in said selective growth approach, it is desirable that the amounts of the particle distributed in the solution to apply are 0.01g or more per 1l. of solutions and 100g or less. The amounts of a particle are 0.1g or more per 1l. of solutions, and 20g or less still more preferably.

[0013] Moreover, as for this invention, in said selective growth approach, it is desirable 1x1016 or more per 1l. of solutions and that the number of the particles distributed in the solution to apply is [or less] 1x1020. The number of particles is [1x1017 or more per 1l. of solutions, and / or less] 1x1019 still more preferably.

[0014] Moreover, as for this invention, in said selective growth approach, it is desirable that the solution to apply is water or alcohol.

[0015] Moreover, as for this invention, in said selective growth approach, it is desirable that said solution is dropped at the substrate material which the method of application of a solution rotated.

[0016] Moreover, for this invention, the spreading consistency of the particle applied on the substrate material in said selective growth approach is per [1x108] square centimeter. It is desirable that it is more than an individual. A spreading consistency is per [1x109] square centimeter still more preferably. It is more than an individual.

[0017] Moreover, as for this invention, in said selective growth approach, it is desirable that the

substrate material to be used is silicon.
[0018] Moreover, as for this invention, in said selective growth approach, it is desirable that the sacrifice layer which carried out the laminating on the substrate material is photoresist material.
[0019] Moreover, as for this invention, in said selective growth approach, it is desirable that the diamond film is formed by the vapor phase synthetic method.
[0020] according to the configuration of this invention approach , it be the approach of form the diamond film alternatively on a substrate material , and since it be characterize by include the process which apply the solution with which mean particle diameter made some fields on a substrate material distribute a particle 0.1 micrometers or less , and the process which grow up the diamond film on said substrate material , the following operations can be do so .
[0021] As for a particle 0.1 micrometers or less, the mean particle diameter applied on the substrate material serves as a site of a growth nucleus in the initial process of diamond film formation. So, control of the growth nucleus at the time of diamond film formation is attained by controlling the number and spreading location of a particle to apply artificially. While the former damages the number of particles and the control of a location which are applied, they are simple as compared with processing and the homogeneity and repeatability of the growth film improve markedly as a result in that case, it becomes possible to obtain a desired diamond film pattern to diamond film growth and coincidence. Although effectiveness is enough acquired as mean particle diameter of the particle to be used by being referred to as 0.1 micrometers or less as above-mentioned, the smaller possible one is good and mean particle diameter is 0.05 micrometers or less desirably.
[0022] Moreover, the process at which mean particle diameter applies the solution which distributed the particle 0.1 micrometers or less on the substrate material which according to the configuration of said this invention approach is the approach of forming the diamond film alternatively on a substrate material, and carried out the laminating of the sacrifice layer to some fields, Since it is characterized by including the process which removes said sacrifice layer, and the process which grows up the diamond film on said substrate material, the following operations can be done so.
[0023] That is, although growth of the diamond film is easily attained because mean particle diameter applies a particle 0.1 micrometers or less on a substrate material as mentioned above, while separation of the growth field of the diamond film becomes easy by using a sacrifice layer as an approach of separating a spreading field, detailed pattern formation becomes easy.
[0024] Moreover, the process at which according to the configuration of said this invention approach it is the approach of forming the diamond film alternatively on a substrate material, and mean particle diameter applies the solution which distributed the particle 0.1 micrometers or less on a substrate material, Since it is characterized by including the process which removes a part of field where said solution was applied, and the process which grows up the diamond film on said substrate material, while separation of the growth field of the diamond film becomes easy like the above-mentioned configuration, detailed pattern formation becomes easy.
[0025] Moreover, in the configuration of this invention approach, since the particle used as a growth nucleus is a diamond particle according to the desirable example that the particle distributed in the solution to apply consists of a diamond, it becomes possible to obtain the good diamond film.
[0026] The amount of the particle distributed in the configuration of this invention approach in the solution to apply Moreover, 0.01g or more per 1l. of solutions, According to the desirable example that they are 0.1g or more per 1l. of solutions, and 20g or less still more desirably, 100g or less of diamonds which grow considering a spreading particle as a nucleus becomes possible [applying easily the particle number of amount sufficient in a short time to become film-like on a substrate material]. When particle size is about 1g and particle size is 0.04 micrometers in general 0.01-micrometer case as optimal particle weight in that case also depending on the particle size of the particle to be used, it is about 16g in general.
[0027] The number of the particles distributed in the configuration of this invention approach in the solution to apply Moreover, 1x1016 or more per 1l. of solutions According to the desirable example that they are 1x1017 or more per 1l. of solutions, and 1x1019 pieces or less still more desirably, 1x1020 or

less pieces The diamond which grows considering a spreading particle as a nucleus becomes possible [applying easily the particle number of amount sufficient in a short time to become film-like on a substrate material] like the above-mentioned configuration.
[0028] Moreover, in the configuration of this invention approach, according to the desirable example that the solution to apply is water or alcohol, while the treatment of a solution is easy, it is the optimal as a distributed solvent of a particle.
[0029] Moreover, according to the desirable example that said solution is dropped at the substrate material which the method of application of a solution rotated, in the configuration of this invention approach, it becomes possible to apply a solution with uniformly and sufficient repeatability also to the substrate material of a big area.
[0030] Moreover, the spreading consistency of the particle applied on the substrate material in the configuration of this invention approach is per [1x108] square centimeter. It is per [1x109] centimeter still more desirably more than an individual. According to the desirable example that it is more than an individual, since the karyogenesis consistency of a big diamond can be obtained in the early stages of growth, a film-like diamond can be obtained in a short time.
[0031] Moreover, in the configuration of this invention approach, according to the desirable example that the substrate material to be used is silicon, while a process configuration becomes easy, fusion in the component and diamond layer using silicon is attained.
[0032] Moreover, in the configuration of this invention approach, while patterning is possible using the photolithography process usually used according to the desirable example that the sacrifice layer which carried out the laminating on the substrate material is photoresist material, it becomes a simple process configuration.
[0033] Moreover, according to the desirable example that the diamond film is formed by the vapor phase synthetic method, in this invention configuration, the good diamond film can be formed easily.
[0034]
[Embodiment of the Invention] Hereafter, this invention is explained still more concretely using an example.
[0035] <Gestalt of the 1st operation> drawing 1 is the schematic diagram of one example of the selective growth approach concerning this invention approach.
[0036] A substrate material is prepared first. (Drawing 1 (a)) Although especially the ingredient used as this base material material is not limited, silicon is used well. The 2 inches silicon substrate 1 was used also in this example.
[0037] Then, after defecating this silicon substrate 1 at the usual washing process, mean particle diameter applied to some fields on a silicon substrate 1 the solution which distributed the diamond particle 2 which is 0.01 micrometers. (Drawing 1 (b)) In this example, the 2g diamond particle 2 was distributed to 1l. pure water, and the solution which added 2 morel. ethanol was used. That is, about 0.67g per 1l. of solutions and the solution with which about 4x1017 diamond particles 2 per 1l. of solutions were contained as a particle number were used as particle weight. Spreading of a solution was performed by dropping a solution directly on a silicon substrate 1. The silicon substrate 1 was dried by the exposure of infrared lamp light after spreading.
[0038] The diamond film 3 was formed with the vapor phase synthetic method on the silicon substrate 1 to which the diamond particle 2 was furthermore applied. (Drawing 1 (c)) Although especially limitation is not carried out as the synthetic approach of the diamond film, it is well used from a vapor phase synthetic method being easy. Generally the gaseous-phase composition approach is performed by decomposing the material gas into material gas using what diluted the carbon source of organic compounds, such as hydrocarbon gas, such as methane, ethane, ethylene, and acetylene, alcohol, and an acetone, a carbon monoxide, etc. with hydrogen. Oxygen, water, etc. can also be further added suitably to material gas in that case. Although especially limitation was not carried out about the applicable vapor phase synthetic method, in this example, the diamond film was formed by the microwave plasma-CVD method. A microwave plasma-CVD method is the approach of plasma-izing and forming a diamond by impressing microwave to material gas. As concrete conditions, the carbon monoxide gas

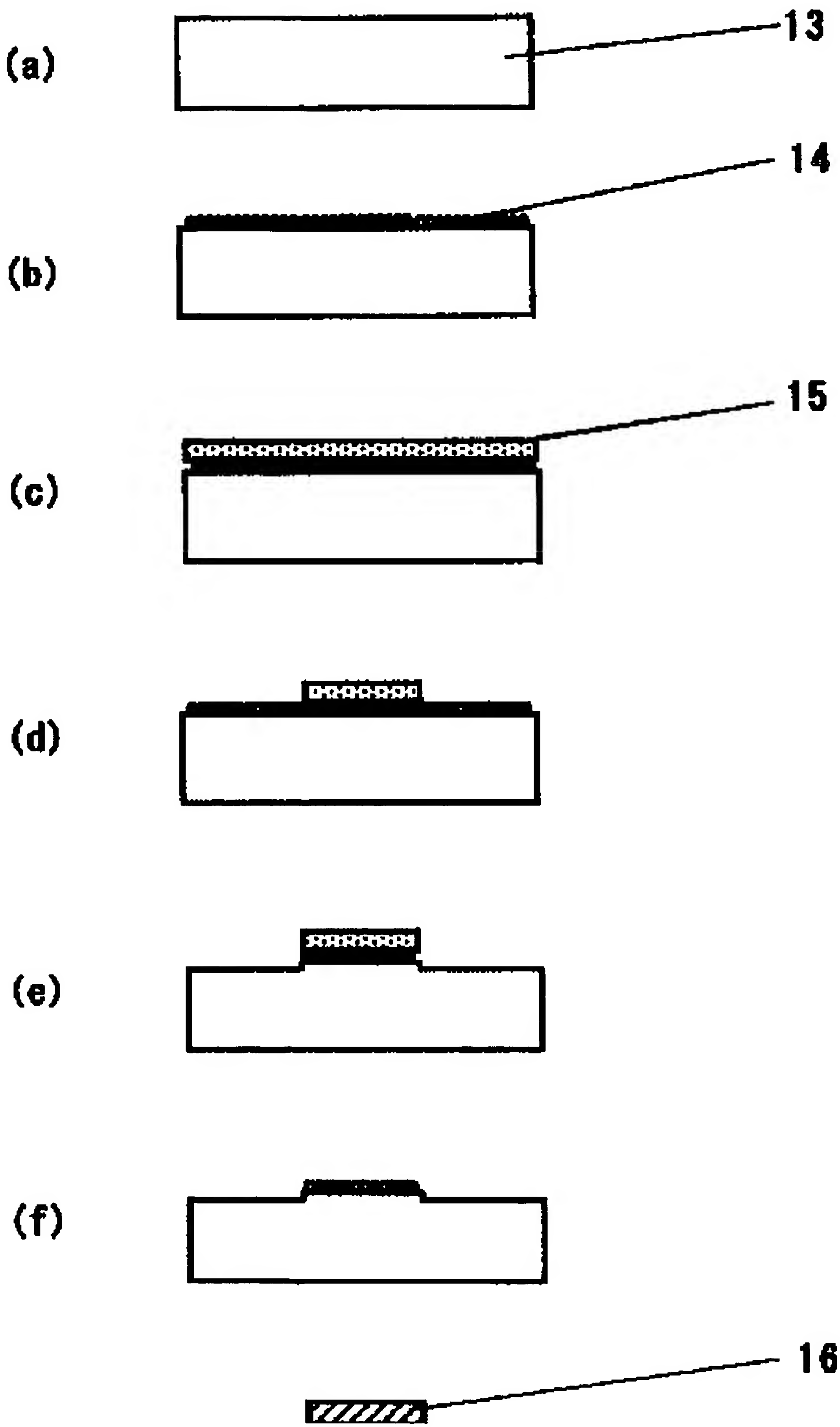
diluted with hydrogen by about 1-10vol% was used for material gas. Reaction temperature and a pressure are 800-900 degrees C and 25 - 40Torr, respectively.
[0039] As a result of forming the diamond film on a silicon substrate by the above approaches, it was checked that the diamond film has grown to be only the part which applied the solution. Moreover, as compared with the case where the former also damaged the film production time amount which the grown-up diamond consists film-like of, and it forms a diamond by processing, it turned out that one half extent is shortened. This is considered to originate in the karyogenesis consistency of a diamond being very large. Then, as a result of investigating the karyogenesis consistency in the growth early stages of the diamond in this example, it was checked that it is larger than about 1x1011 per square centimeter and the conventional substrate pretreatment approach about single figure. That is, it was checked that the selective growth of the good diamond film can be carried out more efficiently than before.
[0040] Moreover, the same result was obtained when the particle size and the amount of a diamond particle which are applied when the diamond film is grown up on other formation conditions were changed, a solution was prepared, and a particle was further changed into silicon carbide.
[0041] <Gestalt of the 2nd operation> drawing 2 is the schematic diagram of other one example of the selection grown method concerning this invention approach.
[0042] A substrate material is prepared first. (Drawing 2 (a)) Although especially the substrate material ingredient was not limited in this configuration, the 2 inches silicon substrate 4 was used in this example.
[0043] Next, after defecating this silicon substrate 4 at the usual washing process, the photoresist material 5 with a thickness of about 2 micrometers was applied. (Drawing 2 (b)) Although not limited about the method of application, in this example, the photoresist material 5 was dropped at the rotated silicon substrate 4, and the approach of using as a coat and the so-called spin coat were used.
[0044] Then, patterning of the photoresist material 5 applied using the technique of the usual photolithography was performed. (Drawing 2 (c)) Although formed in the photoresist material 5 to which the aperture of a dot which consists a round dot with a diameter of 5 micrometers of 100x100 pieces, i.e., 10000 pieces, at intervals of 20 micrometers in this example was applied, it can be made the configuration pattern of arbitration.
[0045] And on the silicon substrate 4 to which the laminating of the photoresist material 5 by which patterning was carried out was carried out, mean particle diameter applied the solution which distributed the diamond particle 6 which is 0.01 micrometers. (Drawing 2 (d)) The used solution is the same as that of the 1st example. Spreading of a solution used the technique of the spin coat same with having applied the photoresist material 5. The silicon substrate 4 was dried by the exposure of infrared lamp light after spreading.
[0046] Then, the solvent for resist removal was permeated 10 minutes or more in the silicon substrate 4 to which the diamond particle 6 was applied, and the photoresist material 5 was removed. (Drawing 2 (e)) Although it is dependent on the quality of the material of the photoresist to be used etc. as a solvent for resist removal, generally organic solvents, such as an acetone, can be used.
[0047] The diamond film 7 was formed by the microwave plasma-CVD method on the silicon substrate 4 from which the photoresist material 5 was furthermore removed. (Drawing 6 (f)) The synthetic conditions of the diamond film are the same as the 1st example.
[0048] As a result of forming the diamond film on a silicon substrate by the above approaches, it was checked that the diamond film has grown to be only the dot field it is 5 micrometers, whose part, i.e., diameter, which applied the solution. Moreover, when removing photoresist material, in spite of having permeated the solvent for resist removal, the pattern configuration of the formed diamond film was the same as that of the pattern of the field where the diamond particle was applied before photoresist removal, and the growth rate of a diamond of it was the same as that of the 1st example. This shows that it has adhered to stability on a substrate material by force, such as Van der Waals force, if an end diamond particle is applied on a substrate material.
[0049] In this example, although the photoresist was used as mask material which classifies the

spreading field of a particle, also when other ingredients were sufficient, for example, patterning was carried out after depositing the amorphous silicon film on a substrate material, and it considered as mask material, the same result was obtained.
[0050] Moreover, the same result was obtained when the particle size and the amount of a diamond particle which are applied when the diamond film is grown up on other formation conditions were changed, a solution was prepared, and a particle was further changed into silicon carbide.
[0051] <the gestalt of the 3rd operation> -- the above-mentioned example usually showed -- like -- the existence of particle spreading -- although selective growth was carried out enough, selective growth of the diamond film was performed on the surface, using as a substrate the silicon which has a diacid-ized silicon layer in order to raise selection growth possibility more. It is because a diamond generally hardly grows on diacid-ized silicon compared with a silicon top by gaseous-phase composition of a diamond. The schematic diagram of other one example of the selective growth approach which starts this invention approach at drawing 3 is shown.
[0052] A silicon substrate 8 is prepared first. (Drawing 3 (a)) The 2 inches silicon substrate was used also in this example.
[0053] Then, after defecating this silicon substrate 8 at the usual washing process, the silicon substrate 8 was installed in the cylinder container made from a quartz, and thermal oxidation heated in a wet oxygen ambient atmosphere was performed. Thermal oxidation conditions are 1000 degrees C and 2 hours. Consequently, the diacid-ized silicon layer 9 was formed in the field of about 1 micrometer of surfaces of a silicon substrate 8 (drawing 3 (b)).
[0054] Next, after applying the photoresist material 10 with a thickness of about 2 micrometers on a spin coat, the desired pattern was formed in the photoresist material 10 at the process of the usual photolithography. (Drawing 3 (c)) The formation pattern is the same as that of the 2nd example.
[0055] Furthermore, etching removal of the diacid-ized silicon layer 9 of a silicon substrate surface was carried out by using the photoresist material 10 as a mask. (Drawing 3 (d)) The wet etching which used the etching reagent of a FUTSU nitric-acid system performed etching of the diacid-ized silicon layer 9. Consequently, the aperture of the round dot whose diameter is 5 micrometers was formed in the part from which the diacid-ized silicon layer 9 was removed like the 2nd example.
[0056] And on the silicon substrate 8 to which the laminating of the photoresist material 10 and the diacid-ized silicon layer 9 by which patterning was carried out was carried out, mean particle diameter applied the solution which distributed the diamond particle 11 which is 0.01 micrometers. (Drawing 3 (e)) The used solution is the same as that of the 1st example. Spreading of a solution used the technique of the spin coat same with having applied photoresist material. The silicon substrate 8 was dried by the exposure of infrared lamp light after spreading.
[0057] Then, the solvent for resist removal was permeated 10 minutes or more in the silicon substrate 8 to which the diamond particle 11 was applied, and the photoresist material 10 was removed. (Drawing 3 (f)) The diamond film 12 was formed by the microwave plasma-CVD method on the silicon substrate 8 from which the photoresist material 10 was removed further. (Drawing 2 (g)) The synthetic conditions of the diamond film are the same as the 1st example.
[0058] As a result of forming the diamond film on a silicon substrate by the above approaches, it was checked that the diamond film has grown to be only the dot field it is 5 micrometers, whose part, i.e., diameter, which applied the solution. And as a result of comparing with the 2nd example, improvement in the selection growth possibility was checked.
[0059] In this example, although the diacid-ized silicon layer was used as the quality of the material of the field where a diamond does not grow, other ingredients are sufficient, for example, the same result was obtained also in the silicon nitride layer.
[0060] Moreover, the same result was obtained when the particle size and the amount of a diamond particle which are applied when the diamond film is grown up on other formation conditions were changed, a solution was prepared, and a particle was further changed into silicon carbide.
[0061] <Gestalt of the 4th operation> drawing 4 is the schematic diagram of other one example of the selective growth approach concerning this invention approach.

[0062] A substrate material is prepared first. (Drawing 4 (a)) Although especially limitation was not carried out for the substrate material ingredient in this configuration, the 2 inches silicon substrate 13 was used in the **** example.
[0063] Next, after defecating a silicon substrate 13 at the usual washing process, mean particle diameter applied the solution which distributed the diamond particle 14 which is 0.01 micrometers on the silicon substrate 13. (Drawing 4 (b)) The used solution is the same as that of the 1st example. Spreading of a solution used the technique of the same spin coat as the 2nd example. The silicon substrate 13 was dried by the exposure of infrared lamp light after spreading.
[0064] Then, the photoresist material 15 with a thickness of about 2 micrometers was applied on the spin coat (drawing 4 (c)).
[0065] And patterning of the photoresist material 15 applied by the technique of the usual photolithography was performed. (Drawing 4 (d)) It formed by the photoresist material 10 to which the dot which consists a round dot with a diameter of 5 micrometers of 100x100 pieces, i.e., 10000 pieces, at intervals of 20 micrometers in this example was applied, and other parts were removed.
[0066] A part of silicon substrate 13 was etched by using as a mask the photoresist material 15 by which patterning was furthermore carried out. (Drawing 4 (e)) About the approach of etching, although especially limitation was not carried out, it carried out etching removal only of about 2 micrometers of the silicon substrates of a non-mask field by this example by reactive ion etching (RIE) using the chlorofluocarbon which mixed oxygen.
[0067] Then, the solvent for resist removal removed the photoresist material 15 (drawing 4 (f)).
[0068] The diamond film 16 was formed in silicon substrate top 13 from which the photoresist material 15 was furthermore removed by the microwave plasma-CVD method. (Drawing 4 (g)) The synthetic conditions of the diamond film are the same as the 1st example.
[0069] As a result of forming the diamond film on a silicon substrate by the above approaches, it was checked that the diamond film has grown to be only the dot field it is 5 micrometers, whose part, i.e., diameter, which applied the solution. Moreover, when removing photoresist material, in spite of having permeated the solvent for resist removal, it was checked that the pattern configuration of the formed diamond film is the same as that of the pattern of the field where the diamond particle was applied before photoresist removal, and the growth rate of a diamond is the same as that of the 1st example.
[0070] In this example, although reactive ion etching was used as etching of a substrate material performed in order to classify the spreading field of a particle, other technique is sufficient, for example, the result with the same said of the wet etching using the solution of a FUTSU nitric-acid system was obtained.
[0071] Moreover, the same result was obtained when the particle size and the amount of a diamond particle which are applied when the diamond film is grown up on other formation conditions were changed, a solution was prepared, and a particle was further changed into silicon carbide.
[0072] For the comparison with the example indicated to the <example of comparison> above, into the solution, the bigger diamond particle than 0.1 micrometers was mixed, and the same experiment was conducted. Consequently, the karyogenesis consistency in the initial process of diamond growth was low single or more figures as compared with the above-mentioned example, and needed twice [more than] as many film production time amount as this to become film-like as a result. Moreover, nonuniformity was in the thickness distribution in a substrate front face, and it was lacking in homogeneity. Furthermore, it was checked that the selection growth possibility of the particle spreading section and an uncoated portion also falls remarkably.
[0073]
[Effect of the Invention] As mentioned above, according to the configuration of the selective growth approach concerning this invention approach, it is the approach of forming the diamond film alternatively on a substrate material. Since it is characterized by including the process at which mean particle diameter applies to some fields on a substrate material the solution which distributed the particle 0.1 micrometers or less, and the process which grows up the diamond film on said substrate material, While the homogeneity and repeatability of the diamond film which grow improve markedly, it becomes

possible to obtain a desired diamond film pattern to diamond film growth and coincidence.
[0074] Moreover, according to the configuration of the selective growth approach concerning this invention approach, it is the approach of forming the diamond film alternatively on a substrate material. The process at which mean particle diameter applies the solution which distributed the particle 0.1 micrometers or less on the substrate material which carried out the laminating of the sacrifice layer to some fields, Since it is characterized by including the process which removes said sacrifice layer, and the process which grows up the diamond film on said substrate material and separation of the growth field of the diamond film becomes easy while the diamond film grows efficiently, detailed pattern formation becomes easy.
[0075] Moreover, the process at which according to the configuration of the selective growth approach concerning this invention approach it is the approach of forming the diamond film alternatively on a substrate material, and mean particle diameter applies the solution which distributed the particle 0.1 micrometers or less on a substrate material, Since it is characterized by including the process which removes a part of field where said solution was applied, and the process which grows up the diamond film on said substrate material and separation of the growth field of the diamond film becomes easy like the above-mentioned configuration, detailed pattern formation becomes easy.
[0076] By using as a diamond the particle distributed in the solution furthermore applied, it becomes possible to obtain the good diamond film.
[0077] It becomes possible to apply easily the particle number of amount sufficient in a short time for a diamond to become film-like on a substrate material by setting still more desirably to 0.1g or more per 1l. of solutions, and 20g or less 0.01g or more per 1l. of solutions of 100g or less of amounts of the particle distributed in the solution furthermore applied.
[0078] A diamond becomes possible [applying easily the particle number of sufficient amount to become film-like on a substrate material] like the above-mentioned configuration for a short time by making still more desirably into 1x1017 or more per 1l. of solutions, and 1x1019 pieces or less the 1x1016 or more number [1x1020 or less] per 1l. of solutions of the particles distributed in the solution furthermore applied.
[0079] By using as water or alcohol the solution furthermore applied, the treatment of a solution becomes easy.
[0080] By considering as solution dropping for the substrate material which furthermore rotated the method of application of a solution, it becomes possible to apply a solution with uniformly and sufficient repeatability also to the substrate material of a big area.
[0081] It is the spreading consistency of the particle furthermore applied on the substrate material per [1x108] square centimeter. It is per [1x109] centimeter still more desirably more than an individual. A film-like diamond can be obtained by carrying out to more than an individual in a short time.
[0082] While a process configuration becomes easy by using as silicon the substrate material furthermore used, fusion in the component and diamond layer using silicon is attained.
[0083] Since patterning is possible using the photolithography process usually used by making into photoresist material the sacrifice layer which furthermore carried out the laminating on the substrate material, it becomes a simple process configuration.
[0084] By furthermore forming the diamond film with a vapor phase synthetic method, the good diamond film can be formed easily.

[Translation done.]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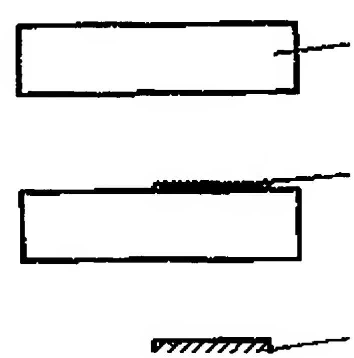
(54)【発明の名称】　ダイヤモンド膜の製造方法

(57)【要約】
【課題】　ダイヤモンド合成時の核発生を簡便な手法で再現性良くかつ効率的に行なうと共に、所望の領域にのみ良質なダイヤモンド膜を形成する方法を提供する。
【解決手段】　基板素材上の一部の領域に平均粒径が０．１μｍ以下の粒子を分散させた溶液を塗布する。基板素材上にダイヤモンド膜を成長させる。これにより、成長するダイヤモンド膜の均一性や再現性が格段向上すると共に、ダイヤモンド膜成長と同時に、所望のダイヤモンド膜パターンを得ることが可能となる。

(a)
(b)



1

【特許請求の範囲】

【請求項1】 基板素材上にダイヤモンド膜を選択的に形成する方法であって、基板素材上の一部の領域に平均粒径が0．1μm以下の粒子を分散させた溶液を塗布する工程と、前記基板素材上にダイヤモンド膜を成長させる工程とを含むことを特徴とするダイヤモンド膜の製造方法。

【請求項2】 基板素材上にダイヤモンド膜を選択的に形成する方法であって、一部の領域に犠牲層を積層した基板素材上に平均粒径が0．1μm以下の粒子を分散させた溶液を塗布する工程と，前記犠牲層を除去する工程と，前記基板素材上にダイヤモンド膜を成長させる工程とを含むことを特徴とするダイヤモンド膜の製造方法。

【請求項3】 基板素材上にダイヤモンド膜を選択的に形成する方法であって、基板素材上に平均粒径が0．1μm以下の粒子を分散させた溶液を塗布する工程と、前記溶液が塗布された領域の一部を除去する工程と，前記基板素材上にダイヤモンド膜を成長させる工程とを含むことを特徴とするダイヤモンド膜の製造方法。

【請求項4】 基板素材上にダイヤモンド膜を選択的に形成する方法であって、塗布する溶液中に分散させた粒子が，ダイヤモンドからなること特徴とする請求項1、2，3のいずれかに記載のダイヤモンド膜の製造方法。

【請求項5】 基板素材上にダイヤモンド膜を選択的に形成する方法であって、塗布する溶液中に分散させた粒子の量が、溶液1リットル当たり0．01g以上，100g以下であること特徴とする請求項1、2、3のいずれかに記載のダイヤモンド膜の製造方法。

【請求項6】 基板素材上にダイヤモンド膜を選択的に形成する方法であって、塗布する溶液中に分散させた粒子の数が、溶液1リットル当たり1×10^{10}個以上，1×10^{20}個以下であること特徴とする請求項1，2，3のいずれかに記載のダイヤモンド膜の製造方法。

【請求項7】 基板素材上にダイヤモンド膜を選択的に形成する方法であって、塗布する溶液が、水あるいはアルコールであること特徴とする請求項1、2、3のいずれかに記載のダイヤモンド膜の製造方法。

【請求項8】 基板素材上にダイヤモンド膜を選択的に形成する方法であって、溶液の塗布方法が、回転した基板素材に前記溶液を滴下することを特徴とする請求項

2

記載のダイヤモンド膜の製造方法。
【請求項11】 基板素材上にダイヤモ
に形成する方法であって，基板素材上に
が，フォトレジスト材であることを特徴
1，2、3のいずれかに記載のダイヤモ
法。
【請求項12】 基板素材上にダイヤモ
に形成する方法であって，ダイヤモンド
法によって形成されること特徴とする請
のいずれかに記載のダイヤモンド膜の製

【発明の詳細な説明】

【0001】
【発明の属する技術分野】本発明は，ダ
製造方法に関するもので，特に、電子工
体や絶縁体層として用いられるダイヤモ
長方法に関する。

【0002】
【従来の技術】近年化学気相合成法（C
方法によって形成されるダイヤモンド膜
ない特性を有する半導体，絶縁体層材料
も注目されている。なぜならダイヤモン
ンドギャップ材料（禁制帯幅：約5．5
その特性はドーピングによって半導体化
度，耐摩耗性，高熱伝導率，化学的に不
様々な分野の電子素子材料として非常に
である。加えてダイヤモンドは、一般に
水素ガスを原料ガスとした気相合成法で
可能であり、製造的な面でも優位性を持

【0003】しかしながら実際に良質な
を形成する際には、形成初期過程におけ
が重要である。なぜなら一般的にシリコ
材上に何等処理することなくダイヤモン
場合，成長核の発生が少なく膜状にする
らである。それ故に従来技術としては，
前処理として，ダイヤモンド砥粒（粒径
μm）を混入させた溶液中に基板素材を
を印加して基板素材の表面を傷付ける
行なっている。

【0004】また得られたダイヤモンド
用するための技術の1つには，ダイヤモ

【０００５】

【発明が解決しようとする課題】上記のようにダイヤモンドの核発生を促すための基板素材の前処理をしては、従来傷付け処理がなされているが、大きな面積を持つ基板素材に対して、処理の面内均一性が不十分であるという問題点があった。また処理バッチ毎に得られる傷付け効果の再現性の点においても課題があった。その結果、傷付け処理部と未処理部で所望の領域にのみダイヤモンド膜を成長させる選択成長も、同様に再現性などの点で課題があった。

【０００６】またマスク材を形成して行なうダイヤモンド膜のエッチングは、マスク材を形成する工程や除去する工程が付与されると共に、ダイヤモンドが比較的エッチングされにくいことやマスク材を積層することによってダイヤモンド膜表面の構造が変化してしまう可能性などがあるなどの課題があった。

【０００７】従って本発明は、従来技術における前記課題を解決するため、基板素材の一部分にのみ平均粒径が０．１μm以下の粒子を分散させた溶液を塗布し、さらに前記基板素材上にダイヤモンド膜を成長させることにより、ダイヤモンド合成時の核発生を簡便な手法で再現性良くかつ効率的に行なうと共に、所望の領域にのみ良質なダイヤモンド膜を形成する選択成長の方法を提供することを目的とする。

【０００８】

【課題を解決するための手段】前記目的を達成するため、本発明に係るダイヤモンド膜の選択成長方法は、基板素材上にダイヤモンド膜を選択的に形成する方法であって、基板素材上の一部の領域に平均粒径が０．１μm以下の粒子を分散させた溶液を塗布する工程と、前記基板素材上にダイヤモンド膜を成長させる工程とを含むことを特徴とするダイヤモンド膜の選択成長方法である。

【０００９】また前記目的を達成するため、本発明に係るダイヤモンド膜の選択成長方法は、基板素材上にダイヤモンド膜を選択的に形成する方法であって、一部の領域に犠牲層を積層した基板素材上に平均粒径が０．１μm以下の粒子を分散させた溶液を塗布する工程と、前記犠牲層を除去する工程と、前記基板素材上にダイヤモンド膜を成長させる工程とを含むことを特徴とするダイヤモンド膜の選択成長方法である。

らなることが好ましい。

【００１２】また本発明は、前記選択成
て、塗布する溶液中に分散させた粒子の
トル当たり０．０１g以上、１００g以
好ましい。さらに好ましくは、粒子の重
ル当たり０．１g以上、２０g以下であ

【００１３】また本発明は、前記選択成
て、塗布する溶液中に分散させた粒子の
トル当たり1×10^{9}個以上、1×10^{19}個
が好ましい。さらに好ましくは、粒子の
トル当たり1×10^{11}個以上、1×10^{17}個

【００１４】また本発明は、前記選択成
て、塗布する溶液が水あるいはアルコー
好ましい。

【００１５】また本発明は、前記選択成
て、溶液の塗布方法が回転した基板素材
下することが好ましい。

【００１６】また本発明は、前記選択成
て、基板素材上に塗布された粒子の塗布
ンチメートル当たり1×10^{6}個以上であ
い。さらに好ましくは、塗布密度が１平
ル当たり1×10^{8}個以上である。

【００１７】また本発明は、前記選択成
て、用いる基板素材がシリコンであるこ

【００１８】また本発明は、前記選択成
て、基板素材上に積層した犠牲層がフォ
あることが好ましい。

【００１９】また本発明は、前記選択成
て、ダイヤモンド膜が気相合成法によっ
とが好ましい。

【００２０】本発明方法の構成によれば
ダイヤモンド膜を選択的に形成する方法
素材上の一部の領域に平均粒径が０．１
を分散させた溶液を塗布する工程と、前
ダイヤモンド膜を成長させる工程とを含
するため、以下のような作用を奏するこ

【００２１】基板素材上に塗布された平
μm以下の粒子は、ダイヤモンド膜形成
て成長核のサイトとなる。それ故に、塗
や塗布位置を人為的に制御してやること

素材上にダイヤモンド膜を選択的に形成する方法であって、一部の領域に犠牲層を積層した基板素材上に平均粒径が０．１μm以下の粒子を分散させた溶液を塗布する工程と、前記犠牲層を除去する工程と、前記基板素材上にダイヤモンド膜を成長させる工程とを含むことを特徴とするため、以下のような作用を奏することができる。

【００２３】すなわち、上記のように基板素材上に平均粒径が０．１μm以下の粒子を塗布することで容易にダイヤモンド膜の成長が可能となるが、塗布領域を分離する方法として犠牲層を用いることにより、ダイヤモンド膜の成長領域の分離が容易になると共に、微細なパターン形成が容易となる。

【００２４】また前記本発明方法の構成によれば、基板素材上にダイヤモンド膜を選択的に形成する方法であって、基板素材上に平均粒径が０．１μm以下の粒子を分散させた溶液を塗布する工程と、前記溶液が塗布された領域の一部を除去する工程と、前記基板素材上にダイヤモンド膜を成長させる工程とを含むことを特徴とするため、上記構成と同様にダイヤモンド膜の成長領域の分離が容易になると共に、微細なパターン形成が容易となる。

【００２５】また本発明方法の構成において、塗布する溶液中に分散させた粒子がダイヤモンドからなるという好ましい例によれば、成長核となる粒子がダイヤモンド粒子であるため、良質なダイヤモンド膜を得ることが可能となる。

【００２６】また本発明方法の構成において、塗布する溶液中に分散させた粒子の量が溶液１リットル当たり０．０１g以上、１００g以下、さらに望ましくは溶液１リットル当たり０．１g以上、２０g以下であるという好ましい例によれば、塗布粒子を核として成長するダイヤモンドが短時間で膜状となるのに充分な量の粒子数を、容易に基板素材上に塗布することが可能となる。その際の最適な粒子量としては、用いる粒子の粒径にも依存し、粒径が０．０１μm場合概ね１g程度、粒径が０．０４μmの場合、概ね１６g程度である。

【００２７】また本発明方法の構成において、塗布する溶液中に分散させた粒子の数が溶液１リットル当たり１×10^{10}個以上、１×10^{20}個以下、さらに望ましくは溶液１リットル当たり１×10^{11}個以上、１×10^{19}個以下であ

好ましい例によれば、大きな面積の基板
均一にかつ再現性良く溶液を塗布するこ
る。

【００３０】また本発明方法の構成におい
上に塗布された粒子の塗布密度が１平方
当たり１×10^{9} 個以上、さらに望ましくは
トル当たり１×10^{9} 個以上であるという
れば、成長初期において大きなダイヤモ
度を得ることができるため、短時間で膜
ドを得ることができる。

【００３１】また本発明方法の構成におい
板素材がシリコンであるという好ましい
ロセス構成が容易になると共に、シリコ
とダイヤモンド層との融合化が可能とな

【００３２】また本発明方法の構成におい
上に積層した犠牲層がフォトレジスト材
ましい例によれば、通常用いられている
フィ工程を用いてパターニングができる
プロセス構成となる。

【００３３】また本発明構成において、
が気相合成法によって形成されるという
れば、容易に良質なダイヤモンド膜を形
きる。

【００３４】

【発明の実施の形態】以下、実施例を用い
らに具体的に説明する。

【００３５】<第１の実施の形態>図１
係る選択成長方法の一実施例の概略図で

【００３６】まず基板素材を準備する。
この基材素材として用いる材料は特に限
はないが、シリコンが良く用いられる。
ても２インチのシリコン基板１を用いた。

【００３７】続いてこのシリコン基板１
程で清浄化した後、シリコン基板１上の
均粒径が０．０１μmのダイヤモンド粒
た溶液を塗布した。（図１（b））本実
トルの純水に２gのダイヤモンド粒子２
に２リットルのエタノールを加えた溶液
わち、粒子量として溶液１リットル当た
g、粒子数として溶液１リットル当たり

の炭化水素ガス、アルコール、アセトン等の有機化合物及び一酸化炭素などの炭素源を水素で希釈したものを用い、その原料ガスを分解することによって行なわれるものである。その際、さらに原料ガスに適宜酸素や水等を添加することもできる。適用可能な気相合成法に関しても特に限定はされないが、本実施例においてはマイクロ波プラズマＣＶＤ法によってダイヤモンド膜の形成を行なった。マイクロ波プラズマＣＶＤ法は原料ガスにマイクロ波を印加することによってプラズマ化し、ダイヤモンドの形成を行なう方法である。具体的な条件としては、原料ガスに水素で１～１０ｖｏｌ％程度に希釈された一酸化炭素ガスを用いた。反応温度及び圧力はそれぞれ８００～９００℃及び２５～４０Ｔｏｒｒである。

【００３９】以上のような方法でシリコン基板上にダイヤモンド膜を形成した結果、溶液を塗布した部分にのみダイヤモンド膜が成長していることが確認された。また成長したダイヤモンドが膜状となる製膜時間も、従来の傷付け処理でダイヤモンドを形成した場合と比較して、半分程度に短縮されることがわかった。このことはダイヤモンドの核発生密度が非常に大きいことに起因するものと考えられる。そこで本実施例におけるダイヤモンドの成長初期における核発生密度を調べた結果、１平方センチメートル当たり約1×10^{11}個と従来の基板前処理方法よりも１桁程度大きいことが確認された。すなわち、従来よりも効率的に良質なダイヤモンド膜が選択成長できることが確認された。

【００４０】また他の形成条件でダイヤモンド膜を成長した場合や塗布するダイヤモンド粒子の粒径や量を変えて溶液を調合した場合、さらには粒子をシリコンカーバイドに変えた場合などにおいても、同様の結果が得られた。

【００４１】<第２の実施の形態>図２は本発明方法に係る選択成長法の他の一実施例の概略図である。

【００４２】まず基板素材を準備する。（図２（ａ））本構成においても基板素材材料は特に限定されないが、本実施例では２インチのシリコン基板４を用いた。

【００４３】次にこのシリコン基板４を通常の洗浄工程で清浄化した後、厚さ約２μｍのフォトレジスト材５を塗布した。（図２（ｂ））塗布方法については限定されるものではないが、本実施例では回転させたシリコン基

材５が積層されたシリコン基板４上に、
０１μｍのダイヤモンド粒子６を分散さ
した。（図２（ｄ））用いた溶液は、第
様である。溶液の塗布は、フォトレジス
たのと同様のスピンコートの手法を用い
リコン基板４は赤外線ランプ光の照射に
た。

【００４６】その後、ダイヤモンド粒子
シリコン基板４をレジスト除去用の溶剤
透し、フォトレジスト材５を除去した。
レジスト除去用の溶剤としては、用いる
の材質等に依存するが、一般的にアセト
剤を用いることができる。

【００４７】さらにフォトレジスト材５
リコン基板４上にマイクロ波プラズマＣ
ダイヤモンド膜７を形成した。（図６（
ンド膜の合成条件は、第１の実施例と同

【００４８】以上のような方法でシリコ
ヤモンド膜を形成した結果、溶液を塗布
ち直径が５μｍのドット領域にのみダイ
長していることが確認された。またフォ
除去する際にレジスト除去用の溶剤に浸
関わらず、形成されたダイヤモンド膜の
フォトレジスト除去前にダイヤモンド粒
いた領域のパターンと同一であり、また
成長速度も第１の実施例と同様であった
一端ダイヤモンド粒子が基板素材上に塗
ァンデルワールス力などの力で安定に基
していることを示している。

【００４９】本実施例においては、粒子
別するマスク材としてフォトレジストを
料でも良く例えばアモルファスシリコン
堆積した後パターニングして、マスク材
様の結果が得られた。

【００５０】また他の形成条件でダイヤ
した場合や塗布するダイヤモンド粒子の
て溶液を調合した場合、さらには粒子を
イドに変えた場合などにおいても、同様
た。

【００５１】<第３の実施の形態>通常

用いた。

【0053】続いてこのシリコン基板8を通常の洗浄工程で清浄化した後、シリコン基板8を石英製の円筒容器に設置し、ウェットな酸素雰囲気中で加熱する熱酸化を行なった。熱酸化条件は1000℃、2時間である。その結果、シリコン基板8の表層約1μmの領域に二酸化シリコン層9が形成された（図3（b））。

【0054】次に厚さ約2μmのフォトレジスト材10をスピンコートで塗布した後、通常のフォトリソグラフィの工程でフォトレジスト材10に所望のパターンを形成した。（図3（c））形成パターンは、第2の実施例と同様である。

【0055】さらに、そのフォトレジスト材10をマスクとして、シリコン基板表層の二酸化シリコン層9をエッチング除去した。（図3（d））二酸化シリコン層9のエッチングは、フッ硝酸系のエッチング液を用いたウェットエッチングにより行なった。その結果、第2の実施例と同様、二酸化シリコン層9が除去された部分に直径が5μmの丸いドットの窓が形成された。

【0056】そしてパターニングされたフォトレジスト材10及び二酸化シリコン層9が積層されたシリコン基板8上に、平均粒径が0．01μmのダイヤモンド粒子11を分散させた溶液を塗布した。（図3（e））用いた溶液は、第1の実施例と同様である。溶液の塗布は、フォトレジスト材を塗布したのと同様のスピンコートの手法を用いた。塗布後、シリコン基板8は赤外線ランプ光の照射によって乾燥された。

【0057】その後、ダイヤモンド粒子11が塗布されたシリコン基板8をレジスト除去用の溶剤に10分以上浸漬し、フォトレジスト材10を除去した。（図3（f））さらにフォトレジスト材10が除去されたシリコン基板8上にマイクロ波プラズマCVD法によってダイヤモンド膜12を形成した。（図2（g））ダイヤモンド膜の合成条件は、第1の実施例と同じである。

【0058】以上のような方法でシリコン基板上にダイヤモンド膜を形成した結果、溶液を塗布した部分すなわち直径が5μmのドット領域にのみダイヤモンド膜が成長していることが確認された。そして第2の実施例と比較した結果、その選択成長性の向上が確認された。

【0059】本実施例においては、ダイヤモンドが成長

【0062】まず基板素材を準備する。本構成においても基板素材材料は特に限が、ほん実施例では2インチのシリコンた。

【0063】次にシリコン基板13を通清浄化した後、シリコン基板13上に平1μmのダイヤモンド粒子14を分散さした。（図4（b））用いた溶液は、第様である。溶液の塗布は、第2の実施例コートの手法を用いた。塗布後、シリコ外線ランプ光の照射によって乾燥された。

【0064】続いて厚さ約2μmのフォ5をスピンコートで塗布した（図4（c

【0065】そして、通常のフォトリソで塗布されたフォトレジスト材15のパなった。（図4（d））本実施例においの丸いドットを20μm間隔で100×わち10000個からなるドットを塗布ジスト材10で形成して、他の部分は除

【0066】さらにパターニングされた材15をマスクとして、シリコン基板1ッチングした。（図4（e））エッチンいては、特に限定はされないが、本実施合したフロンガスを用いた反応性イオンIE）により未マスク領域のシリコン基けエッチング除去した。

【0067】その後、フォトレジスト材除去用の溶剤で除去した（図4（f））。

【0068】さらにフォトレジスト材1シリコン基板上13にマイクロ波プラズってダイヤモンド膜16を形成した。（イヤモンド膜の合成条件は、第1の実施る。

【0069】以上のような方法でシリコヤモンド膜を形成した結果、溶液を塗布ち直径が5μmのドット領域にのみダイ長していることが確認された。またフォ除去する際にレジスト除去用の溶剤に浸関わらず、形成されたダイヤモンド膜のフォトレジスト除去前にダイヤモンド粒

て溶液を調合した場合、さらには粒子をシリコンカーバイドに変えた場合などにおいても、同様の結果が得られた。

【0072】＜比較例＞上記に記載した実施例との比較のために、溶液中に0．1μmよりも大きなダイヤモンド粒子を混合して同様の実験を行なった。その結果、ダイヤモンド成長の初期過程における核発生密度は、上記実施例と比較して1桁以上低く、その結果膜状となるのに2倍以上の製膜時間が必要であった。また基板表面内の膜厚分布にムラがあり、均一性に乏しかった。さらには粒子塗布部と未塗布部との選択成長性も著しく低下することが確認された。

【0073】

【発明の効果】以上のように、本発明方法に係る選択成長方法の構成によれば、基板素材上にダイヤモンド膜を選択的に形成する方法であって、基板素材上の一部の領域に平均粒径が0．1μm以下の粒子を分散させた溶液を塗布する工程と、前記基板素材上にダイヤモンド膜を成長させる工程とを含むことを特徴とするため、成長するダイヤモンド膜の均一性や再現性が格段向上すると共に、ダイヤモンド膜成長と同時に、所望のダイヤモンド膜パターンを得ることが可能となる。

【0074】また本発明方法に係る選択成長方法の構成によれば、基板素材上にダイヤモンド膜を選択的に形成する方法であって、一部の領域に犠牲層を積層した基板素材上に平均粒径が0．1μm以下の粒子を分散させた溶液を塗布する工程と、前記犠牲層を除去する工程と、前記基板素材上にダイヤモンド膜を成長させる工程とを含むことを特徴とするため、効率的にダイヤモンド膜が成長すると共に、ダイヤモンド膜の成長領域の分離が容易になるので、微細なパターン形成が容易となる。

【0075】また本発明方法に係る選択成長方法の構成によれば、基板素材上にダイヤモンド膜を選択的に形成する方法であって、基板素材上に平均粒径が0．1μm以下の粒子を分散させた溶液を塗布する工程と、前記溶液が塗布された領域の一部を除去する工程と、前記基板素材上にダイヤモンド膜を成長させる工程とを含むことを特徴とするため、上記構成と同様にダイヤモンド膜の成長領域の分離が容易になるので、微細なパターン形成が容易となる。

数を溶液1リットル当たり1×10²⁰個以
以下、さらに望ましくは溶液1リットル
個以上、1×10¹⁹個以下とすることによ
同様に、短時間でダイヤモンドが膜状と
の粒子数を容易に基板素材上に塗布する
る。

【0079】さらに塗布する溶液を水あ
ルとすることにより、溶液の扱いが容易

【0080】さらに溶液の塗布方法を回
への溶液滴下とすることにより、大きな
に対しても均一にかつ再現性良く溶液を
可能となる。

【0081】さらに基板素材上に塗布さ
密度を1平方センチメートル当たり1×
らに望ましくは1センチメートル当たり
とすることにより、短時間で膜状のダイ
ことができる。

【0082】さらに用いる基板素材をシ
とにより、プロセス構成が容易になると
を用いた素子とダイヤモンド層との融合
る。

【0083】さらに基板素材上に積層し
トレジスト材とすることにより、通常用
ォトリソグラフィ工程を用いてパターニ
で、簡便なプロセス構成となる。

【0084】さらにダイヤモンド膜を気
て形成することにより、容易に良質なダ
形成することができる。

【図面の簡単な説明】

【図1】本発明方法に係る選択成長方法
す概略図

【図2】本発明方法に係る選択成長方法
を示す概略図

【図3】本発明方法に係る選択成長方法
を示す概略図

【図4】本発明方法に係る選択成長方法
を示す概略図

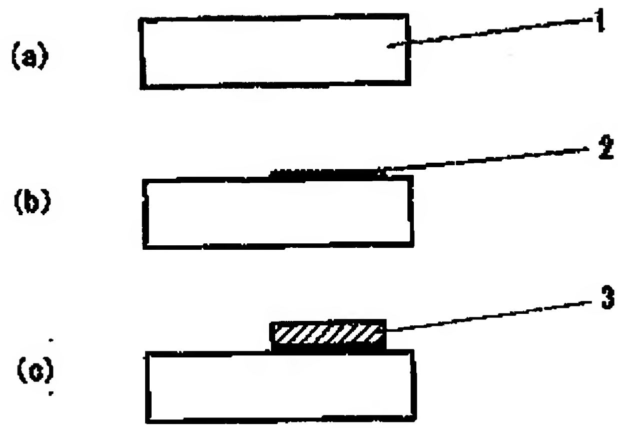
【符号の説明】

1 シリコン基板

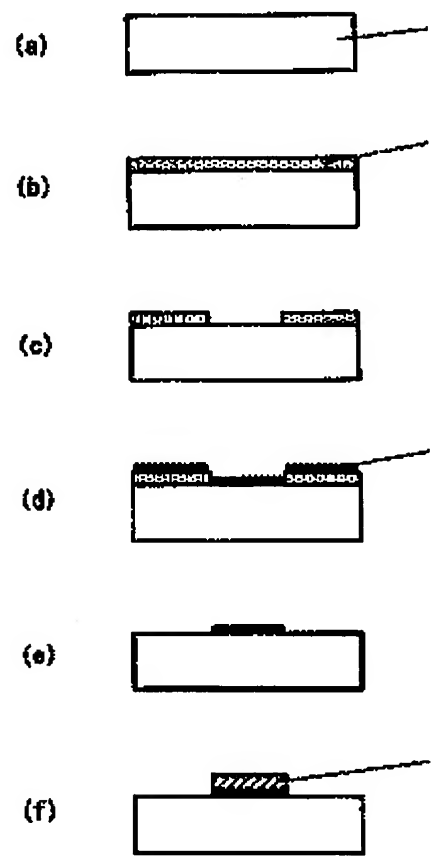
2 ダイヤモンド粒子

13　シリコン基板
14　ダイヤモンド粒子
＊15　フォトレジスト材
＊　16　ダイヤモンド膜

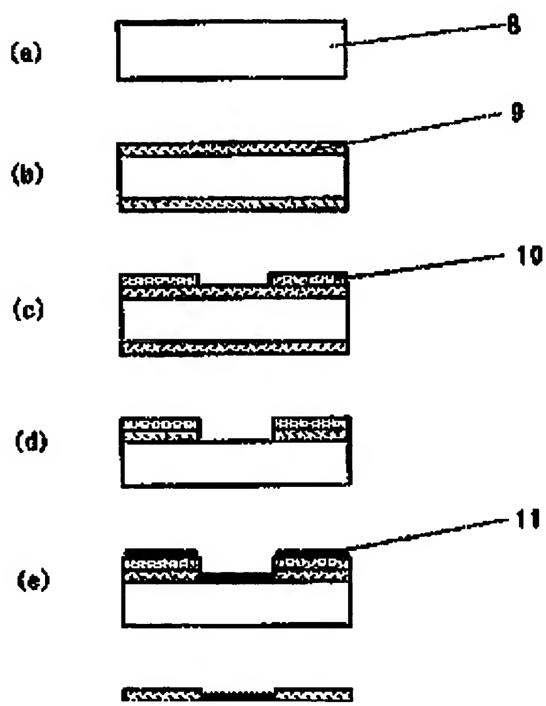
【図1】



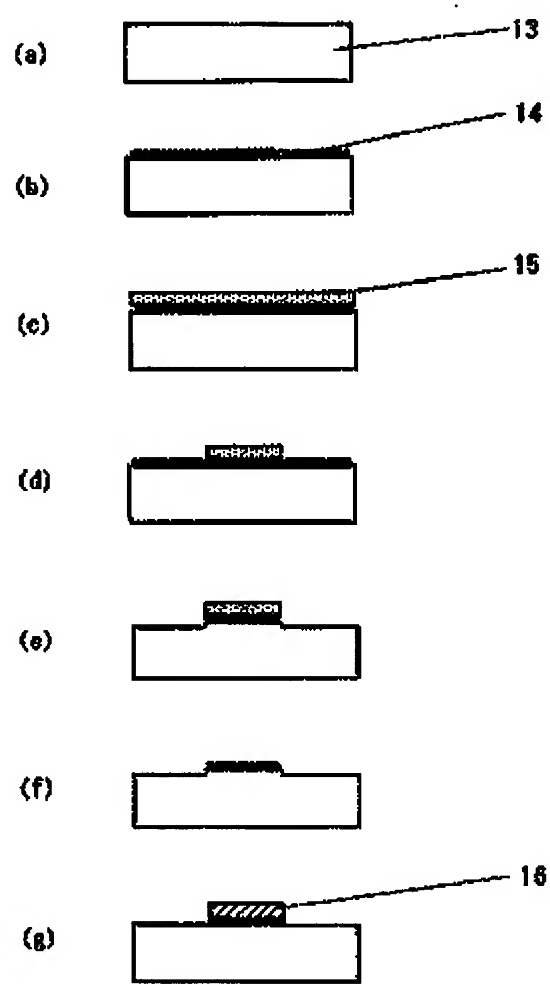
【図2】



【図3】



【図4】



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